

Guest Lecture

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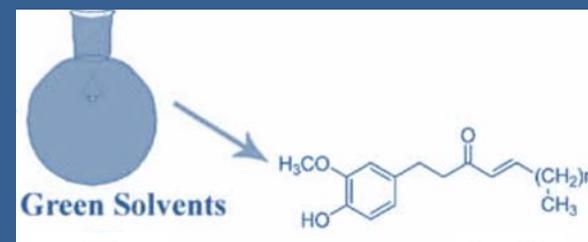
Students and guests are very welcome!

Natural deep eutectic solvents: “You see it when you understand it”

Prof. em. Dr. Rob Verpoorte

Speaker: Prof. em. Rob Verpoorte, Leiden University, The Netherlands

Prof. Rob Verpoorte is from the Natural Products Laboratory, Institute Biology Leiden, Leiden University. He is author/co-author of more than 800 publications, 6 patents and 3 books. The research is widely cited and places him among the 1% most cited authors in Clarivate, Web of Science (Cross-Field; 2018–2021). A citation analysis made by Stanford University placed the impact of his work on position 45 (out of 134,814 authors) in the field of chemistry (2020, 2021). Prof. Verpoorte has served as editor of journals such as the Editor-in-Chief of Journal of Ethnopharmacology and Phytochemical Reviews, and Executive Editor of Biotechnology Letters. He obtained numerous prizes.



Thursday, June 9, 2022
11:10 – 12:00

Lecture Hall H EG 05, Alte Chemie, Heinrich-Buff-Ring 62

Natural deep eutectic solvents:

“You see it, when you understand it”*

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Through NMR-based metabolomics we found that in all kind of extracts of microbial, mammalian and plant cells certain organic bases, organic acids, amino acids, sugars and sugar alcohol occur in relatively large amounts. Much larger in fact than expected on the basis of these compounds being intermediates in primary metabolism. Their ubiquitous occurrence gave us the thought that they must have a function. Based on this our first hypothesis was the possibility of ionic liquids formed by the organic bases like choline and betaine with organic acid like malic acid. The first experiments confirmed this. Further studies resulted in finding that various combinations of the mentioned compounds do give deep eutectic solvents, i.e. mixing these solid crystalline compounds in certain molar ratios results in liquids at room temperature. More than 150 combinations now have been characterized. We named them Natural Deep Eutectic Solvents (NADES). They can be divided into the following groups:

- Organic bases with organic acids: ionic liquids
- Organic bases with neutral compounds like poly alcohols and sugars
- Organic acids with neutral compounds like poly alcohols and sugars
- Amino acids with neutral compounds like poly alcohols and sugars
- Mixtures of neutral compounds like poly alcohols and sugars

By ¹HNMR it was shown that the NADES components are strongly bound via H-bonding, in some cases H₂O is part of these liquid crystal-like structures. The NMR also shows that with dilution with water gradually the interaction between the compounds disappears. NADES are excellent solvents for medium polar compounds, such as most secondary metabolites. In our view biosynthesis of poorly water soluble compounds occurs in NADES, e.g. attached to cellular membranes, where the polar charged head groups of the membrane lipids act as anchors for NADES in which enzymes and intermediates are dissolved. Also the ER and vesicles could be formed by metastable systems of lipids and NADES. The occurrence of NADES in certain seeds could be proven by NOESY experiments with fully ¹³C labeled seeds. All ingredients for NADES are found in resurrection plants, lichen etc. Also in drought or cold resistant plants typical NADES ingredients are found to be present. In terms of application the NADES are excellent solvents for both small molecules and macromolecules (proteins, polysaccharides, DNA, etc.) in which the compounds show better solubility and stability than in the currently used organic solvents. NADES thus are of interest as non-toxic, non-explosive, sustainable green solvents for many industrial applications. In cosmetics the introduction of NADES for making novel products has been very successful as the NADES add new possibilities for natural solvents for making plant extracts. Also in food NADES will find applications, in fact honey is a NADES. In traditional Chinese medicine frying plant materials with honey is applied, it was shown that the biological activity of the end product is modified.

There are still many things to be learned from Nature!

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Y Dai, R Jin, R Verpoorte, W Lam, YC Cheng, Y Xiao, J Xu, L Zhang, X Qin, P Li, and . Chen. Natural deep eutectic characteristics of honey improve the bioactivity and safety of traditional medicines. J Ethnopharmacol, 250(2020) art no. 112460

*Quote from Johan Cruijff